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Invention: POWER OPERATED PISTON TOOL WITH PISTON
AUTOMATIC RETURN

PCT Application No PCT/PL98/00052

SPECIFICATION

Power operated piston tool with
piston automatic return

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5 *Background of The Inventions*
Field of the Inventions
a1 The object of this invention is a power operated piston tool with piston automatic return

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10 In power operated piston tools, of indirect action, designed for driving fastening elements into a base like masonry, concrete, wood or the like, a piston element, driven by firing gases, coming from firing cartridge, is used as an intermediary element, acting upon the fastener, as opposite to tools of direct action, where firing gases act directly upon fastening element.

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15 In tools of indirect action, the piston after fastening is in its forward position, *that its piston tip* ~~that is piston shank tip~~ is at the fastener guide muzzle end. In order to return the piston to its firing position, in conventional, semiautomatic tools, manual reloading is required. This reloading consists of pulling backward the barrel means, having a returning tooth, engaging the respective cavity on piston means, which causes the piston to return. This

20 operation is also used to shift the firing cartridge belt about one position, thus making the tool ready for next firing.

25 In other kind of power piston tools, described in patent EP 0223740, the piston return is actuated by the firing gases, which, after pushing the piston to its forward position, while still expanding, cause the piston to retract. However, after retracting, the piston strikes against its rear abutment, thus causing the reflection effect, which may displace the piston of some distance from its firing position, creating a dead space, decreasing the firing power of a subsequent fire. As a result,

30 fasteners are driven into the base at uneven depth and the firing chamber becomes spoiled with firing remains, due to incomplete

burning of blowing charge. Besides, problems can occur when the piston itself is driven into the base after fastening operation. In that case, to return the piston to its firing position,
 35 an additional manual push-rod is needed. In any case, after transporting or other periods of prolonged disuse of the tool, it is always useful to check with manual push-rod, whether the piston is well in its firing position, the only one initial position ensuring tool correct functioning.

40 In another kind of power piston tool, illustrated in US patent No 3,331,546, to return the piston member, a plurality of stacked washers constructed from polyurethane elastomer, are applied. The washers are positioned within the barrel, on the piston shank. After firing the washers are rapidly collapsed,
 45 thus absorbing part of firing energy and functioning as a buffer. At the end of power stroke, and after dissipation of the firing gases, escaping through vent holes in the barrel, the washers will return to their original shape, due to elastic memory, and thus they return piston to its firing position. The venting holes,
 50 situated in washers' side portions cause stress concentration and thus damage to spring elements. The other problem arises when exchanging worn-out washer elements, as they require strictly defined positions and quantity, otherwise malfunction
 may occur, if not a serious tool damage.

55 ²³ It is an object of this invention to provide a power operated piston tool, free from above mentioned imperfections, in which the piston return is carried-out mechanically, by use of one-piece elastic returning bush. The returning bush is situated on piston shank between piston head and fastener guide, is
 60 made of elastomeric material and has a shape of ⁴⁴ ~~bellow~~ ^{bellows}, whose diameters both external and internal are regularly varied. The walls of so formed returning bush are approximate in shape to a

sinusoid, or to a stack of frusto-spherical segments, or frusto-conical segments, or stack of barrel-shape segments or/and
65 other surface of revolution segments, creating uniformly spaced swellings and narrowings of wave like structure.

The returning bush according to this invention advantageously has the maximal internal diameter of at least one segment at its both ends of slightly smaller size than the
70 respective diameter of remaining segments, so the end segment walls are thicker than others segment walls.

The internal end surface of external segments is markedly curved outside in such a way, that the position of curvature points of bush ends is clearly distanced from bush face. The
75 length of returning bush is selected in such a way that after initial blocking, the piston shank end face does not reach its extreme forward position and remains at a distance from the base, the distance slightly greater than the head height of fastening element. The maximal external diameter of returning
80 bush according to present invention is smaller enough than the internal diameter of guiding barrel, that, after initial blocking of the bush, its external diameter still remains smaller than internal diameter of guiding bush, thus preserving the slight clearance.

85 After driving fully the fastening element into the base, and subsequent stopping the piston movement, the energy accumulated in the returning bush is being relieved and rejects the piston to the rear, due to shape memory of elastomeric material. It is the first and the greatest returning force acting
90 upon the piston. After returning the piston to its rear position, there remains some slight force due to not fully recovering the bush free shape, which force retains the piston in its rear position that is firing position.

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The object of this invention is illustrated in a preferable embodiment in the accompanying drawings in which fig 1 is a longitudinal cross sectional view of the power piston tool, showing the piston in its firing position, at the moment of firing the cartridge, fig 2 is the same view showing the piston at the end of normal power stroke, at the moment of driving the fastening element into a base, after initial blocking of returning bush, fig 3 is the same view after driving the fastening element fully into the base, fig 4 is the cross sectional view of middle part of the returning bush and fig 5 is somewhat enlarged view of one of returning bush end in cross section.

Description of Invention and Preferred Embodiment
 In power tool shown in fig 1 a piston 1, mounted for reciprocation within the guiding barrel 2, is in its firing position at the rear end of the barrel 2 where the piston head 12 is, as near, as possible, to the firing chamber 4. On piston shank 11, between the piston head 12 and fastener guide 5 an elastic returning bush 7 is situated, being in the shape of one piece bellows, constructed from an elastomer, whose diameters both external and internal are regularly varied. The walls of so formed returning bush 7 are approximate in shape to a stack of frusto-spherical segments, creating uniformly spaced swellings and narrowings of wave like structure. In another embodiment of the invention the returning bush is of shape of stack of frusto-conical segments. In yet another embodiment of the invention, the returning bush is of shape of the stack of barrel shape segments or/and another surface of revolution segments. The returning bush 7 has the maximal internal diameter D4, of its extreme two segments at its both ends, of slightly smaller size than the respective diameter D2 of remaining segments, so that the bush end segment walls are a little thicker than other segments walls. The internal end surface of external segments

125 is markedly curved outside in such a way, that the position 71 of
 curvature points of bush ends is clearly distanced from the bush
 faces 72. The length of the returning bush 7 is selected in such
 a way that after initial blocking of the returning bush 7, the
 piston shank 1 end face does not reach its extreme forward
 130 position and remains at a distance from the base 30, the
 distance slightly greater than the head height of fastening
 element 6. The maximal external diameter D1 of the returning
 bush 7 is smaller enough than the internal diameter of the
 guiding barrel 2, that, after initial blocking of the returning bush
 135 7, its external diameter still remains smaller than internal
 diameter of the guiding ^{barrel} ~~bush~~ 2, thus preserving a slight
 clearance. When the piston 1 is in its firing position, an initial
 stress within the returning bush 7 remains, enough to ensure
 that the piston head 12 abuts the bottom of the barrel 2, near
 140 the firing chamber 4. On the piston head 12 there is a plurality
 of grooves 121, acting as sealing means for firing gases and
 providing some space to gather impurities. Ports A in the
 guiding barrel 2 and ports B and C in external barrel 8 are
 provided to enable the firing gases evacuation after firing.

145 After firing the cartridge 9 upon striking the firing pin 20,
 the firing gases set the piston 1 into motion, with rapidly
 accelerating velocity, towards the fastener 6. Piston head 12,
 after passing the port A, opens gas flow connection toward the
 space between the guiding barrel 2 and external barrel 8 and
 150 from there, through port B toward ⁸¹ ~~silencer~~ 11, and from there,
 via port C, into the atmosphere, thus reducing the firing noise
 and gas pressure in firing chamber, to value close to
 atmospheric pressure. Accelerated piston 1 strikes against
 fastener 6, driving it into base 30, and at the same time,
 155 compressing the returning bush 7. At a distance of several

millimeters before fully setting the fastener 6 into the base 30 initial blocking of the returning bush 7 takes place. In this position the piston shank 1 and face does not reach its extreme forward position and remains at some distance from the base 30 slightly greater than the head height of fastener 6 and a clearance exists between the guiding barrel 2 and returning bush 7. The returning bush 7, at the final stage of the piston 1 motion, forms a shut tubular column, thus absorbing little firing energy which ensures driving the fastening element 6 to the full depth. In the event of free flight shot or overdrive of the piston, this shut tubular column will function as a buffer, to absorb the high energy of the piston 1.

After thrusting the fastener 6 into the base 30, the piston 1 stops and due to elastic memory, inherent in elastomeric material, the returning bush 7 will return the piston 1 to its firing position, where it is ready for the next firing operation, the more easier that the counter-pressure acting upon the piston 1 from the firing chamber 4, has fallen to atmospheric pressure.

To reload the power piston tool, it should be removed from the contact with the base 30, then the springs of firing-pin assembly move the subassembly of piston 1 and its guiding barrel 2 forward, about a stroke, enabling : first to remove the used firing cartridge 9 from the firing chamber 4 and, secondly, after the tool is pressed anew against base 30 for the subsequent firing, to shift the cartridge belt 40 about one position.

By virtue of particular configuration of the elastic returning bush 7, during the normal power stroke, substantially little energy will be absorbed by the returning bush 7 being pressed, and thus there will be little interference with the velocity of the piston 1, so the bulk of firing energy is used for driving the

a fastener ⁶7 into base 30, while only small portion of this energy will be [^]used for returning the piston 1 to its firing position, thus reducing the tool reflection effect and ensuring that the piston 1,
190 will always return to its firing position, after venting the space behind its head 12. The particular wave like shape of returning bush 7, as well as, thickening the bush 7 end segments and particular position of curvature points of bush 7 ends ensures correct functioning of the tool and eliminates the elastomeric
195 bush tendency to curl, which tendency could drive to a situation when the piston 1 could be blocked within the guiding barrel 2. Besides, the returning bush 7 does not oppose a great resistance to the piston 1 movement, so it does not brake its velocity and it does not impair the effectiveness of fastening the
200 fasteners and does not provoke any tool reflection effect.

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